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CERTIFICATE

This certificate is issued in support of an application for Patent registration in a country outside New Zealand pursuant to the Patents Act 1953 and the Regulations thereunder.

I hereby certify that annexed is a true copy of the Provisional Specification as filed on 12 February 2004 with an application for Letters Patent number 531103 made by SYFT Technologies Limited.

Dated 13 December 2004.

Neville Harris
Commissioner of Patents, Trade Marks and Designs

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PROVISIONAL SPECIFICATION

Improvements in or relating to instruments for the analysis of volatile organic chemicals.

We, **SYFT Technologies Limited**, a New Zealand company, of 3 Craft Place, Middleton, Christchurch, New Zealand, do hereby declare this invention to be described in the following statement:

TITLE:

Improvements in or relating to instruments for the analysis of volatile organic chemicals.

Background to the invention

In particular the invention relates to an instrument that utilises selected ion flow tube (SIFT), or selected ion flow drift tube (SIFDT) technique which is a fast flow tube/ion swarm method for the study of positive or negative ions with atoms and molecules. A selected ion flow tube can either be a drift tube which has a potential gradient applied to it or a flow tube which has no gradient applied to it. In the following description, the general term flow tube is therefore intended to encompass both forms of technique, that is SIFT-MS and SIFDT-MS.

In SIFT and SIFDT apparatus, the ions are created in an ion source which is external to the flow tube. The ions are then extracted from the ion source by a quadrupole mass filter which acts on the incident ion beam to create a pure species of ion beam (precursor). An electrostatic lens is then used to focus the ion beam which is injected into one end of a flow tube or drift tube which has a flowing carrier gas, usually helium. The carrier gas is prevented from entering the quadrupole mass filter by being injected into the flow tube through a venturi orifice in a direction away from the orifice. This enables the swarm of single ion species to be thermalised in a flow tube at the same temperature as the carrier gas flows along the flow tube and quickly establishes a laminar flow of gases through the flow tube. The flow tube or drift tube communicates via a downstream orifice with a downstream chamber housing a quadrupole mass spectrometer system where the ions are mass analysed and counted.

This form of instrument requires a chamber for the upstream quadrupole mass filter which is connected by the flow tube to a separate generally substantially identical chamber in which the downstream quadrupole mass spectrometer is housed. To allow the quadrupole mass filters to operate effectively, the interiors of both the upstream and the downstream chambers are pressurised at a pressure generally of about 10^{-6} Torr which is

created by individual pumps. The pressure in the flow tube is generally much greater than the pressure in the chambers and generally is in the order of 0.5 to 1.0 Torr.

Because of the requirement of having separate chambers and because of the comparatively substantial size and capacity of the two pumps, a SIFT-MS or a SIFDT-MS instrument is of a substantial size. In addition because of the type of the pumps needed, considerable noise can be created when the instrument is operating. If the instrument is to be made at all portable, it is highly desirable that the instrument including the pumps be housed within a suitably small structure and because of the size and capacity of the pumps it is necessary that considerable attention also be given to adequate sound deadening.

Object of the invention

It is therefore an object of this invention to provide an improved instrument for analysis of volatile organic chemicals and which has a flow tube which utilises SIFT-MS or SIFDT-MS technique.

It is a further object of this invention to provide a SIFT-MS or SIFDT-MS instrument which can be more transportable than previously known instruments and in which the size and combined weight of the various components of the instrument, particularly the high pressure pumps can be downsized from that previously known.

Disclosure of the invention

Accordingly in one form the invention comprises

an instrument for the analysis of volatile organic compounds and which includes a downstream quadrupole mass filter and an upstream quadrupole mass filter housed together within a single evacuated chamber and

a curved flow tube connecting the outlet of the upstream quadrupole mass filter to the inlet of the downstream quadrupole mass filter, the said flow tube being pressurised at a higher pressure than that of the chamber.

Preferably the flow tube acts as a drift tube and has a potential gradient applied to it.

Preferably the flow tube acts as a flow tube and has no potential gradient applied to it.

Preferably a non-reactive gas (or mixture of such gases) is injected into the flow tube to flow through the tube by the action of a vacuum pump.

Preferably the non-reactive gas is helium.

Preferably the injection of the non reactive gas or mixture of gases is effected through a venturi orifice and the design of the curved flow tube and venturi orifice contributes to a laminar flow of the gas-ion mixture through the flow tube.

Preferably the flow tube is curved.

Preferably the flow tube includes two bends which join a straight tube.

Preferably the precursor ion beams from the upstream quadrupole mass filter are injected into one end of the flow tube.

Preferably the chamber is evacuated by a single pump.

Preferably an electrostatic shield is located in the chamber to separate the upstream quadrupole mass filter from the downstream quadrupole mass filter.

Preferably an electrostatic lens is associated with the upstream quadrupole mass filter.

Preferably an electrostatic lens is associated with the downstream quadrupole mass filter.

Brief description of the drawings

Figure 1 is a schematic diagram of a known form of SIFT-MS or SIFDT-MS instrument.

Figure 2 is a schematic diagram of the improved form of SIFT-MS or SIFDT-MS instrument according to the present invention.

Description of the preferred embodiments of the invention.

As illustrated in Figure 1, a known form of SIFT-MS or SIFDT-MS instrument may comprise an upstream chamber 1 to which an ion source 2 is connected. The upstream chamber houses a quadrupole mass filter 3 through which the ion stream is passed. The upstream chamber is held at a pressure, generally 10^{-6} Torr to enable correct operation of the quadrupole 3. The ion stream is focused by the lens 4 before it passes through an ion injection orifice located as part of the venturi plate 8, to enter the flow tube 6.

The flow tube or flow drift tube 6 is generally held at a pressure of approximately 0.5 to 1.0 Torr and a stream of a non-reactive carrier gas or gas mixture, typically helium is injected at 8 into the flow tube in a manner that a venturi effect is obtained to prevent the ion stream from the chamber 1 and the non-reactive gas from escaping back into the upstream chamber. Additional non-reactive carrier gas or gas mixture can be injected at additional points along tube 6.

The sample of the volatile organic compound (VOC) is injected at 7 into the flow tube and reacts with the incident beam of ions, the result of which is a transfer of ions to the VOC. The charged VOCs then enter the downstream chamber through a small injection orifice 11 with the downstream chamber 10 generally held at a similar pressure (10^{-6} Torr) to the upstream chamber 1. As in the case of the upstream chamber, the downstream chamber 10 is normally evacuated by means of a turbo pump 12 or similar. The downstream chamber includes a set of lenses 13 and a quadrupole mass filter 14 with a detector device 15 by which the masses of the incident VOCs and precursor ions are

measured. Backing pumps are shown at 16 and these allow the chambers 1 and 10 to be evacuated sufficiently to allow turbo pumps 12 to maintain the desired chamber pressure.

The improved SIFT-MS or SIFDT-MS instrument is illustrated diagrammatically in Figure 2. As illustrated, the upstream chamber 1 and the downstream chamber 10 of Figure 1 are dispensed with and a single combined chamber 20 is provided which is evacuated by a single pump 21 preferably at a pressure of 10^{-6} Torr. The chamber 20 includes an upstream quadrupole 22 and lens 23 to extract the ions from the ion source 2 with the extracted ions being focused through the lens and injected into a flow tube or flow drift tube 24 through which a stream of non-reactive carrier gas is passed. The flow tube or flow drift tube 24 is maintained at an appropriate pressure, typically 0.5 Torr by a pump 26. The flow tube or flow drift tube 24 instead of being an essentially straight tube which connected an upstream chamber to a downstream chamber as in the case of the prior art instrument illustrated in Figure 1, in the improvement provided by this invention, the flow tube or flow drift tube is curved as illustrated. The sample VOCs are injected into the flow tube or flow drift tube 24 to react with the beam of ions which then enters the chamber 20 through an ion sampling orifice 25 where it is focused by the lens 28 into the quadrupole mass filter 29 which acts as a mass selector prior to analysis by the detector 15. An appropriate electrostatic shield (not shown in the drawing) is located within the chamber 20 to electrostatically separate the quadrupole mass filter 22 and lens 23 from the lens 28 and quadrupole mass filter 29. Backing pumps are shown at 30 and these allow the chamber 20 to be evacuated sufficiently to allow turbo pump 21 to maintain the desired chamber pressure.

As in the case of the instrument illustrated in Figure 1, a non-reactive gas such as helium and the precursor ions are injected into one end of the flow tube and flow along the tube, the flow being created by the action of the vacuum pump. It is therefore possible to maintain laminar flow after injection of the sample VOCs.

Because of the improvements in the instrument brought about by the present invention, it is possible to make the whole instrument considerably physically smaller with

less componentry that that previously required. This provides significant savings in the cost in the manufacture of the instrument. In addition, because only a single pump is used, less electrical power is required and less noise is generated. This reduces the considerable amount of sound insulation that was previously required. It is to be understood this is a major advantage when constructing the instrument as a portable instrument because this will result in a reduction of the number of component parts and consequently in the size of the machine and in the weight of the machine

Having described the preferred embodiments of the invention it will be apparent to those skilled in the art that various changes and alterations can be made to the embodiments and yet still come within the general concept of the invention. All such changes and alterations are intended to be included in the scope of this specification